Multi-Step Automatic Calibration Scheme (MACS)

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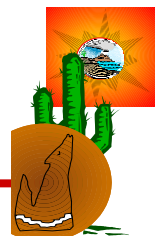
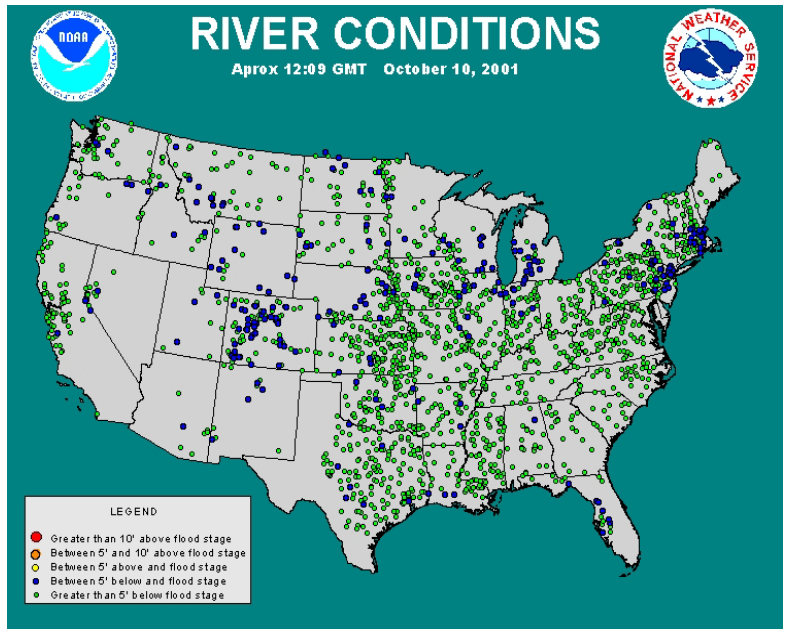


AHPS = Calibration Issues

~ 4000 River Forecast Points

Small % with calibrations



***Manual** – reliable, quality,*

but TIME-CONSUMING

***Automatic** – reliable, quality,*

and EFFICIENT (fewer man-hours)

GOAL:

Advanced Calibration Techniques → NWSRFS

= Within existing code !!

Manual vs. Automatic Calibration

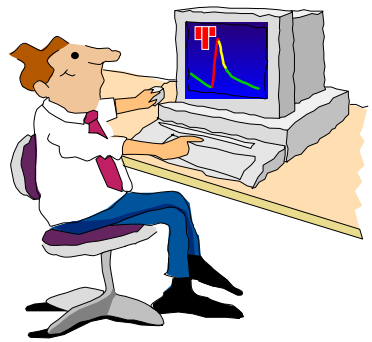
Manual

User knowledge

Excellent model calibrations

Complicated and highly labor intensive

Expertise not easily transferred



Automatic

User knowledge

Speed and power of computer

Objective procedure

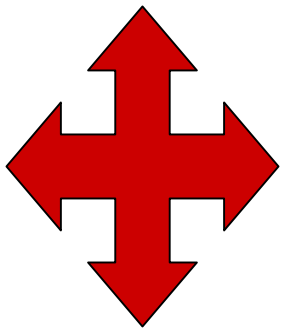
Easy to use

→ **Results not generally acceptable**

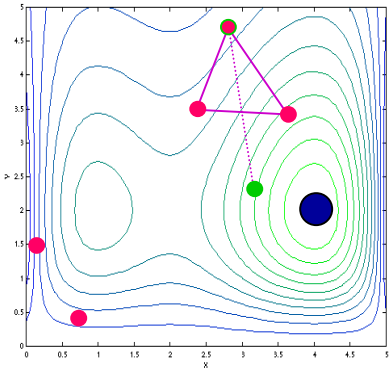
Automatic Calibration

Objective Function (Root Mean Square)

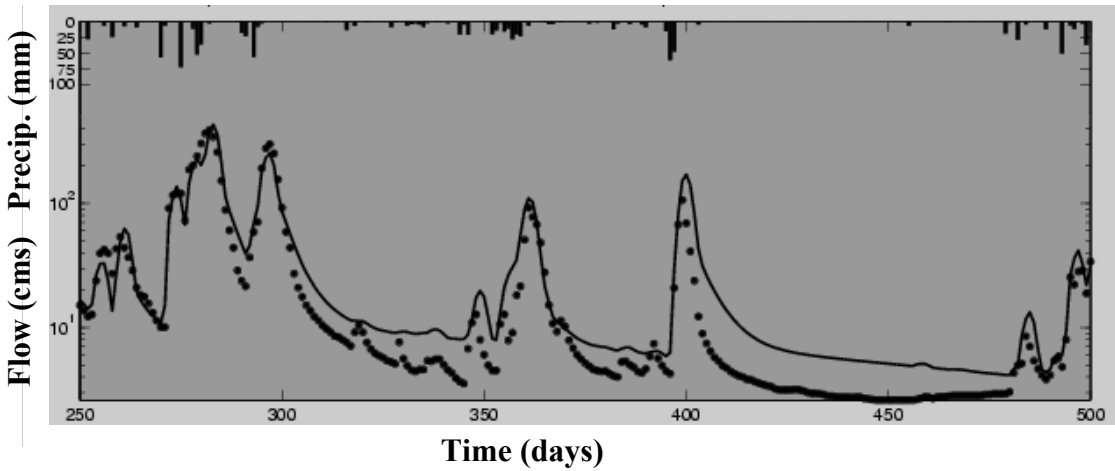
$$DRMS = \sqrt{\frac{1}{n}\left(\sum_{t=1}^{n}(Q_{sim,t} - Q_{obs,t})^2\right)}$$



Optimization Algorithm (SCE-UA)

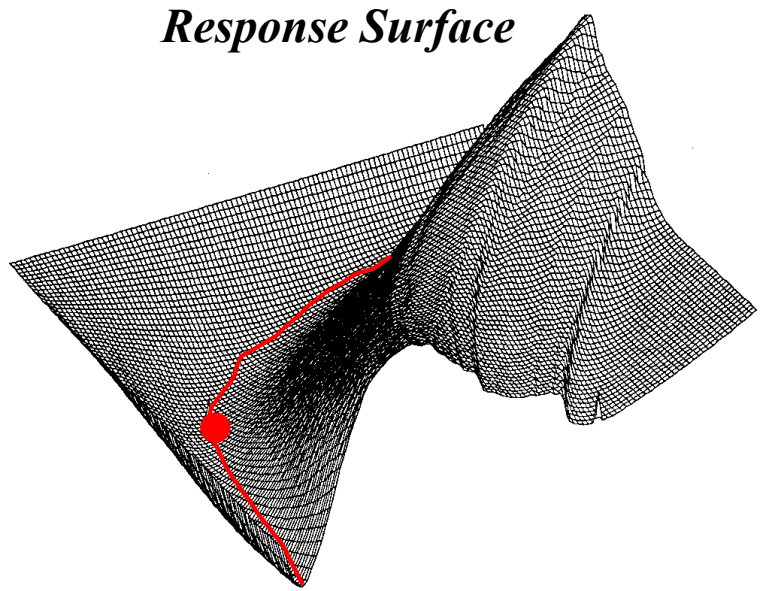


Historical Data



Difficulties in Optimization

1.- Regions of Attraction	*More than one main convergence region*
2.- Local Optima	*Many small "pits" in each region*
3.- Roughness	*Rough surface with discontinuous derivatives*
4.- Flatness	*Flat near optimum with significantly different parameter sensitivities*
5.- Shape	*Long and curved ridges*

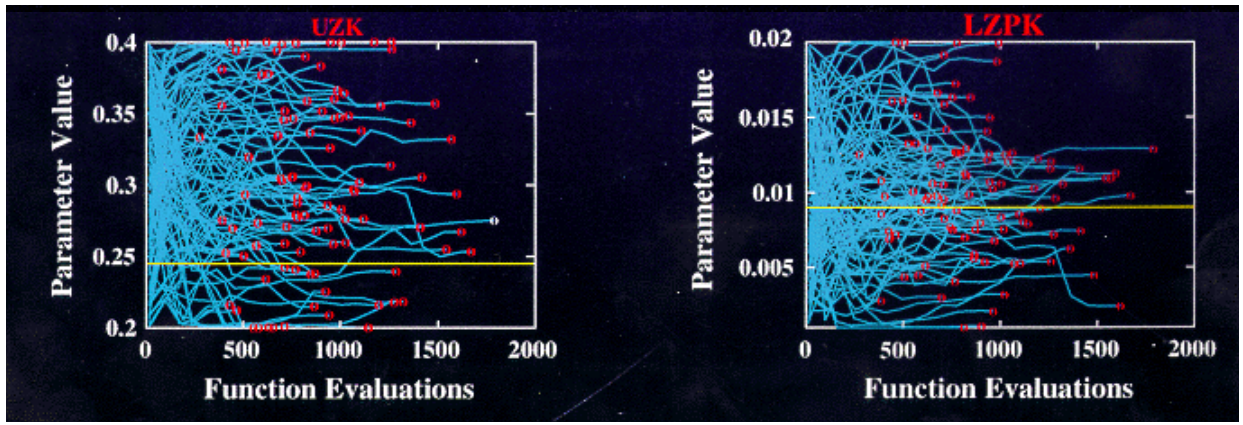


Development of "Global Search Algorithm: SCE-UA"

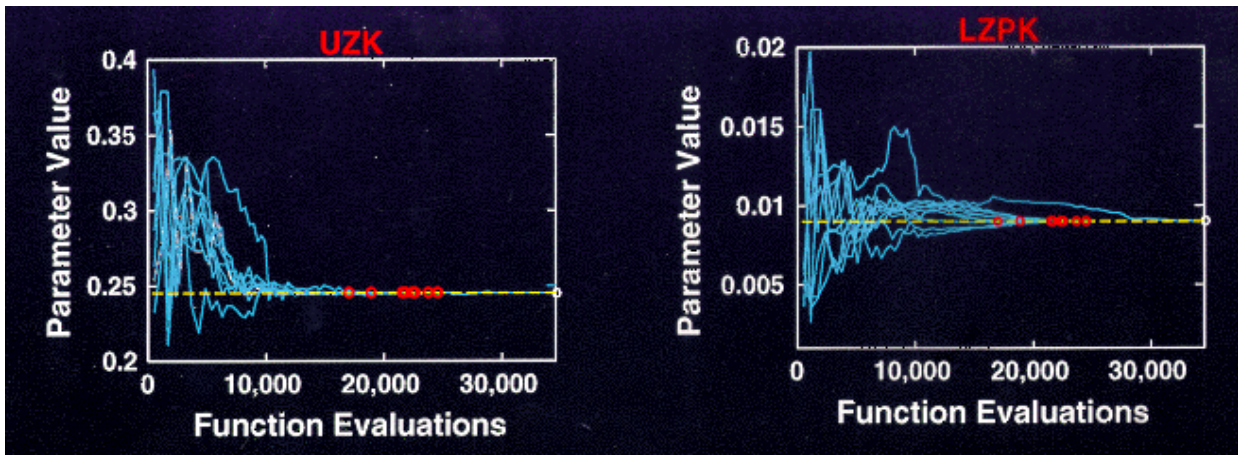
Duan, Gupta, and Sorooshian, 1992

Performance: SCE-UA vs. Simplex

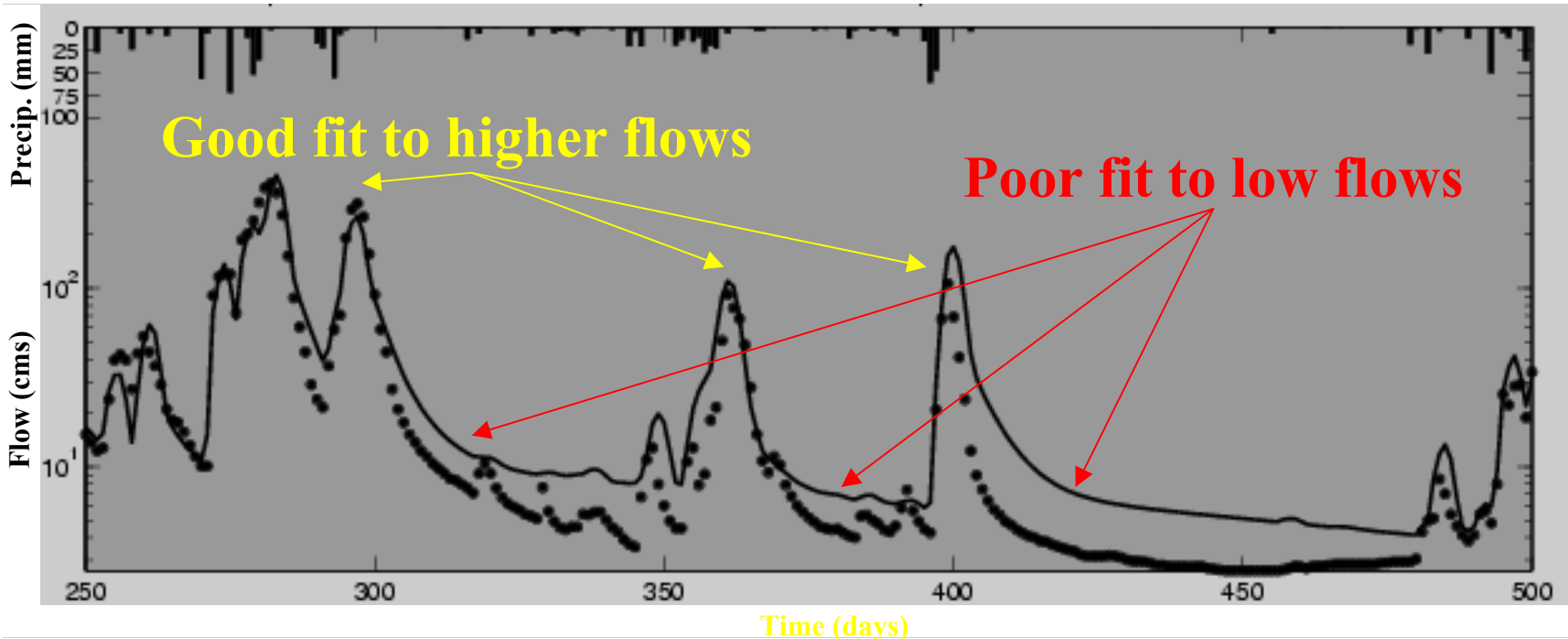
Simplex



SCE - UA



Motivation for Multi-step / Multi-objective



Results from Automatic single criteria calibration of SAC-SMA model

Multi-step Automatic Calibration Scheme (MACS)

- **3-step automatic calibration process**
- **Use of different objective functions with various model parameters**
- ***Process:***
- **1) Baseflow Parameters**
- **2) High Flow Events – Snow melt, etc.**
- **3) Fine-tuning – baseflow, ET parameters …**

Multi-step Automatic Calibration Scheme (MACS)

SNOW-17

SCF	SI
MFMAX	MFMIN

SAC-SMA

Upper Zone

UZTWM	PCTIM
UZFWM	UZK

ZPERC	REXP

SAC-SMA

Lower Zone

LZTWM	LZFSM	LZFPM
LZSK	LZPK	PFREE

2 – DRMS (10)

$$DRMS = \sqrt{\frac{1}{n}\left(\sum_{t=1}^{n}\left(Q_{sim,t} - Q_{obs,t}\right)^2\right)}$$

1 - LOG (16)

$$LOG = \sum\left(LOG_{Q_{simt}} - LOG_{Q_{obst}}\right)^2$$

3 - LOG (6)

Methods for Calibration

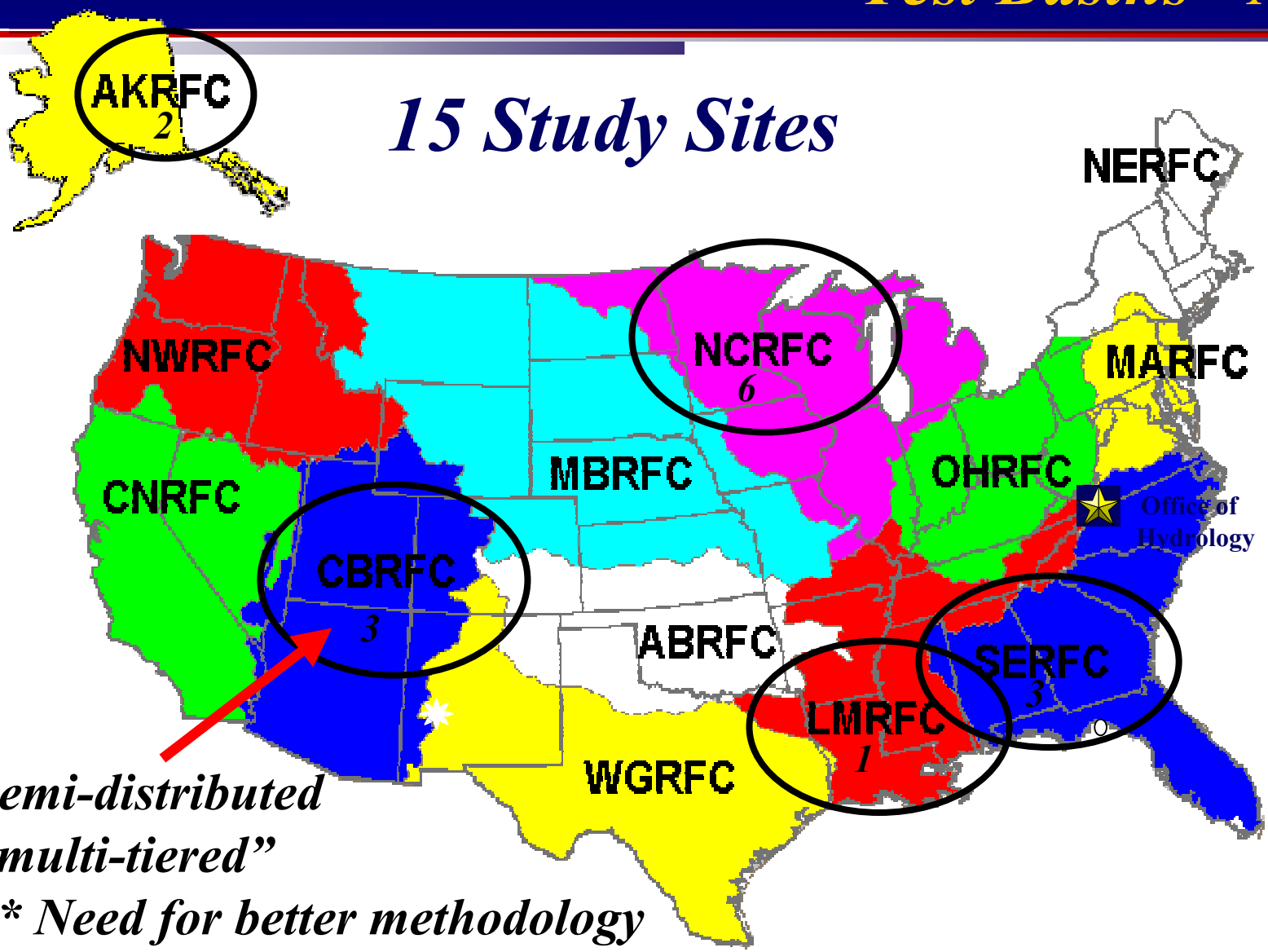
- ***15 Headwater Basins*** **– varying size (160-5195 km²)**
  - **10 lumped basins**
  - **5 multi-level basins (elevation bands)**

- **~ 40 years historical data**
  - **Calibration: ~ 11 years**
  - **Validation: ~ 40 years (entire period)**

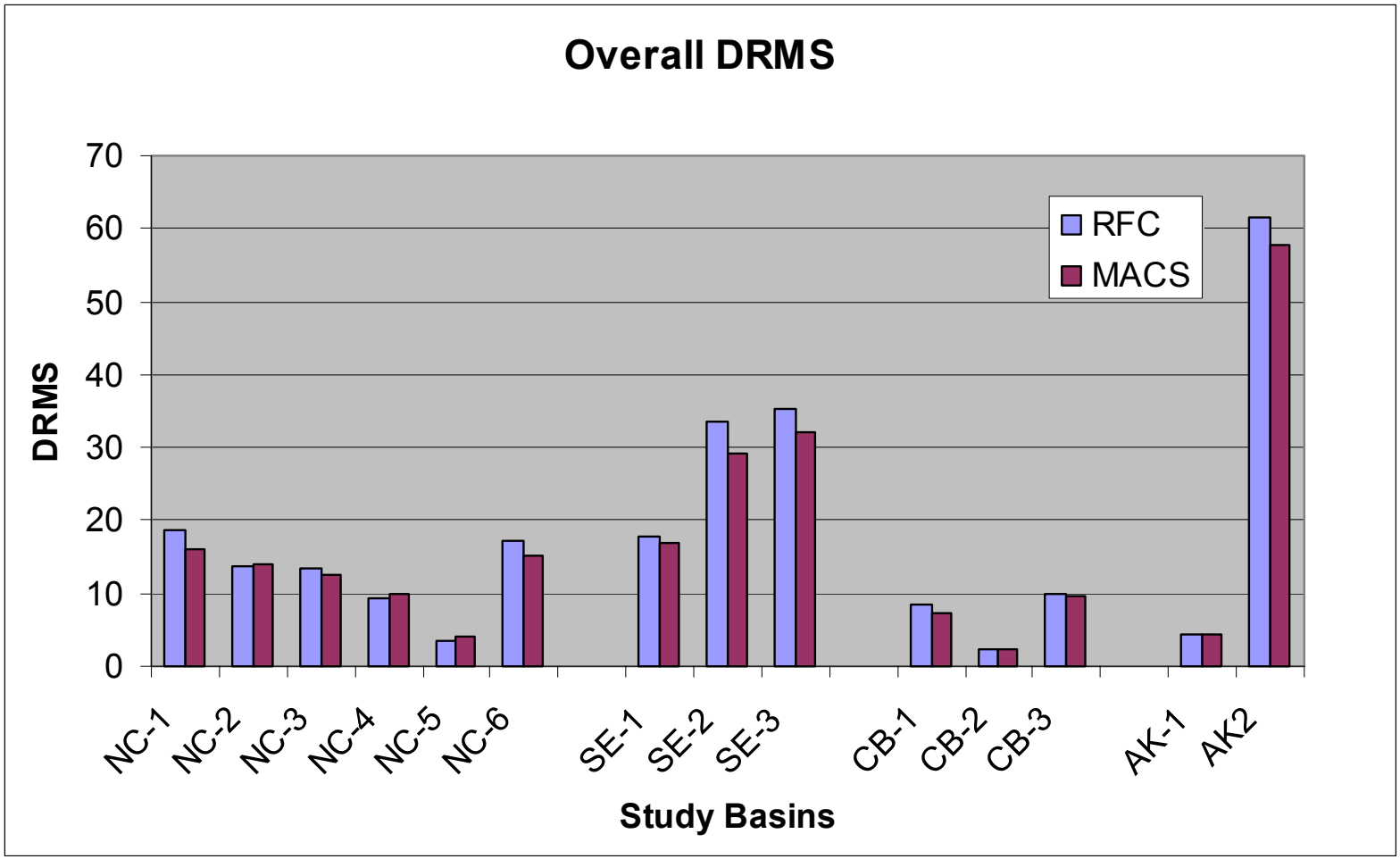
- **RFC parameter ranges**
- **RFC statistics / hydrographs for evaluation**

  DRMS, %Bias, Monthly statistics, etc…

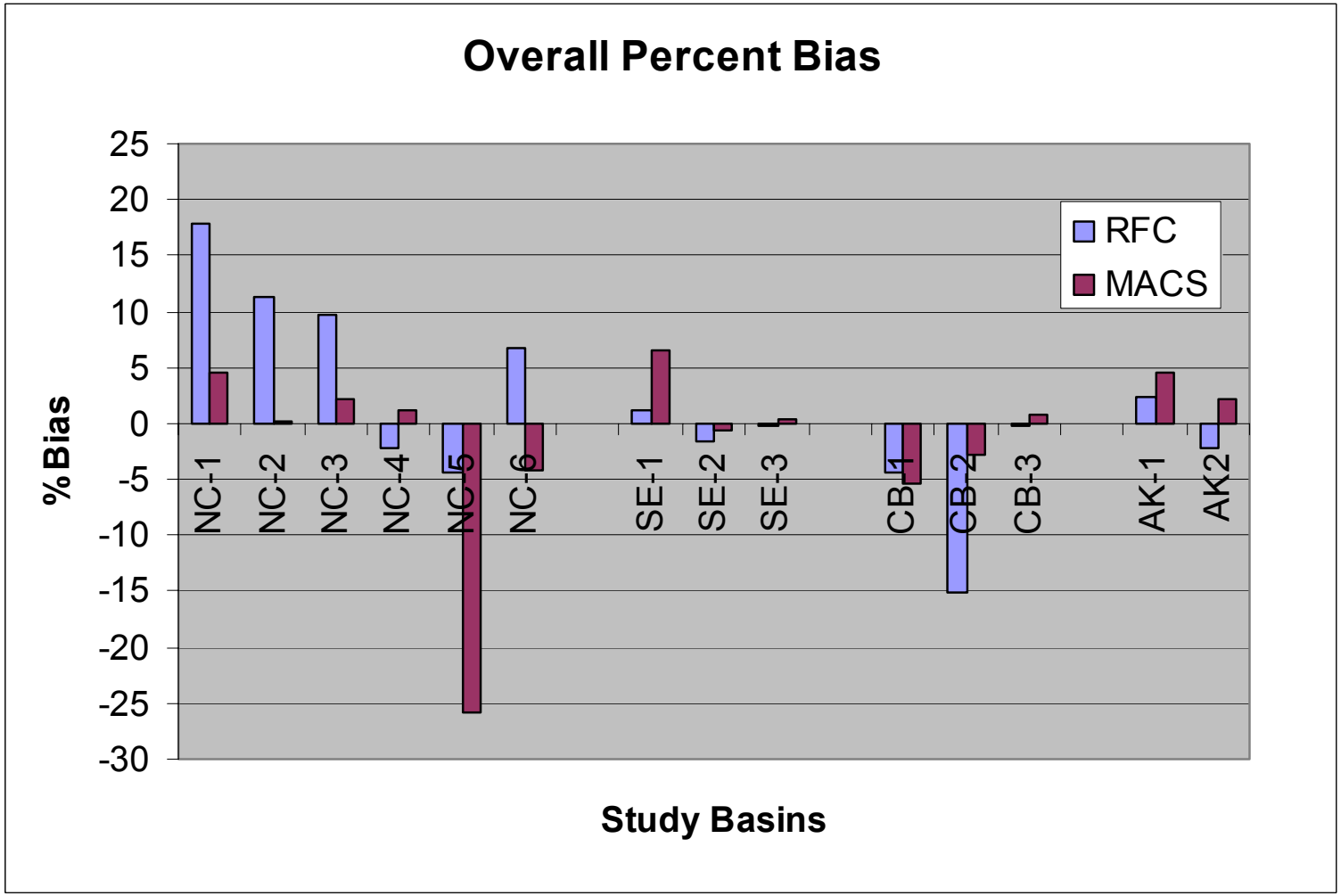
Test Basins - NWS



Evaluation of Calibrations



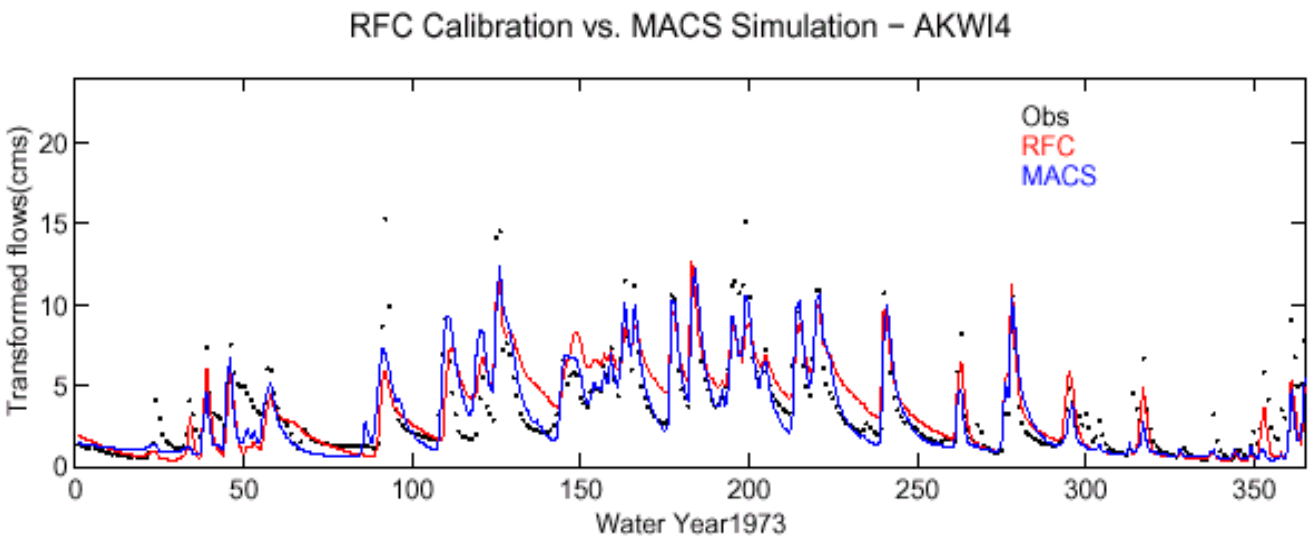
Evaluation of Calibrations



Multi-step Automatic Calibration Scheme (MACS)

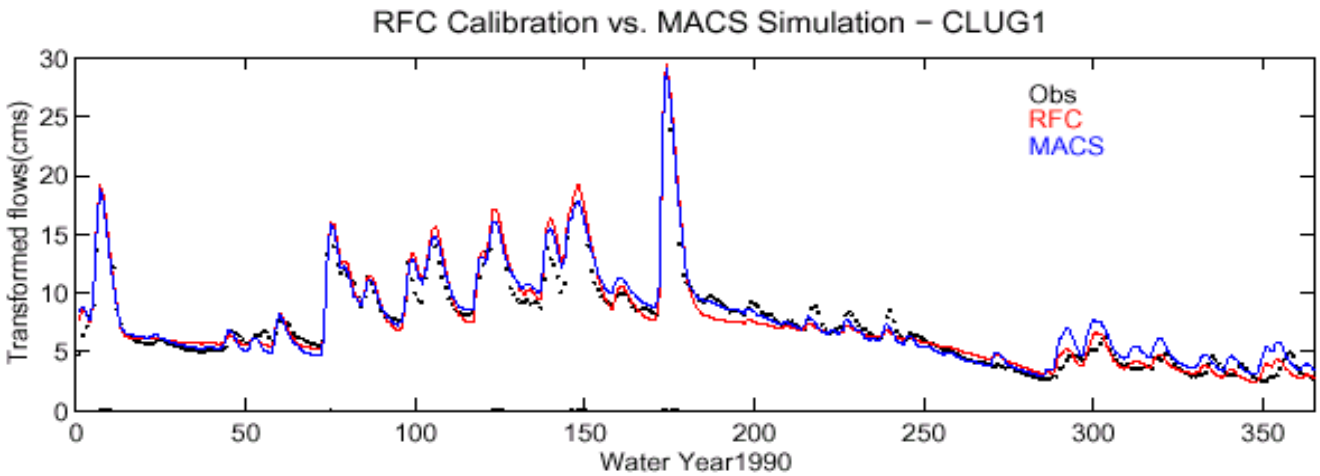
NCRFC

South River, IA



SERFC

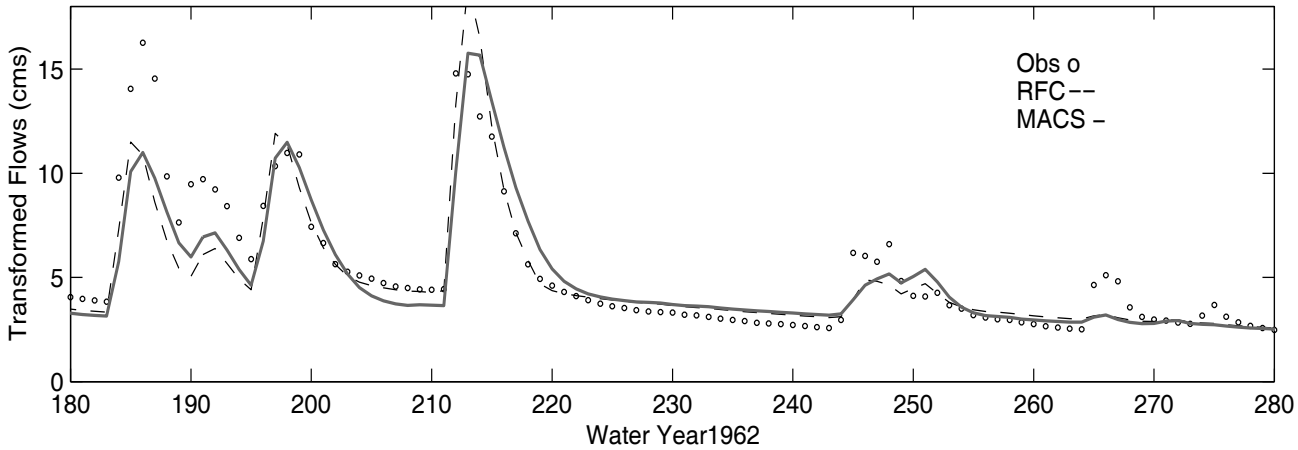
Flint River, GA



Multi-step Automatic Calibration Scheme (MACS)

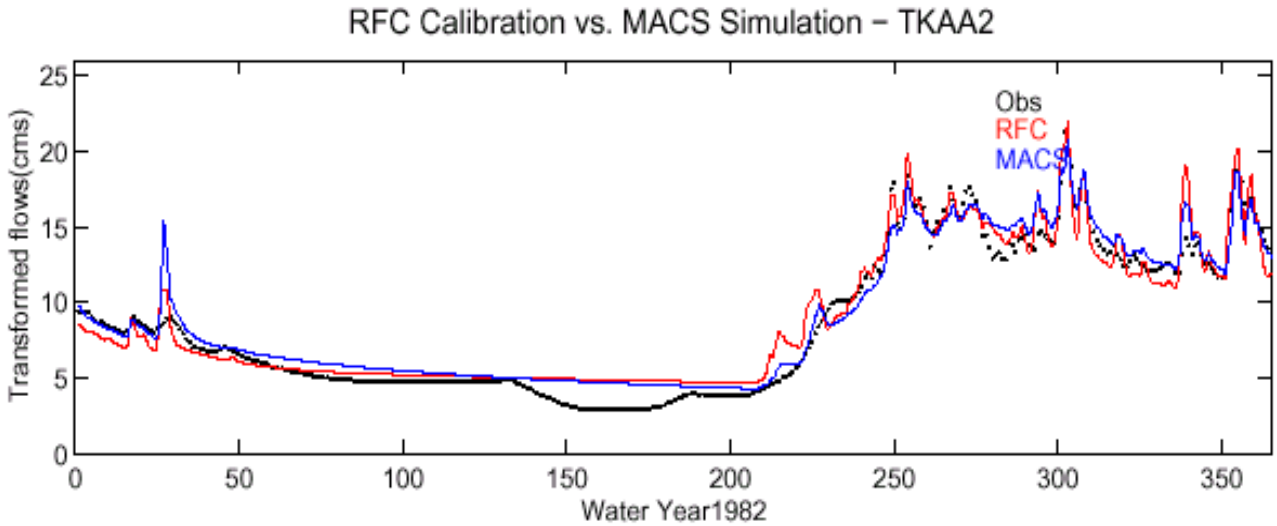
LMRFC

Leaf River



AKRFC

Talkeetna River



CBRFC – previous work !

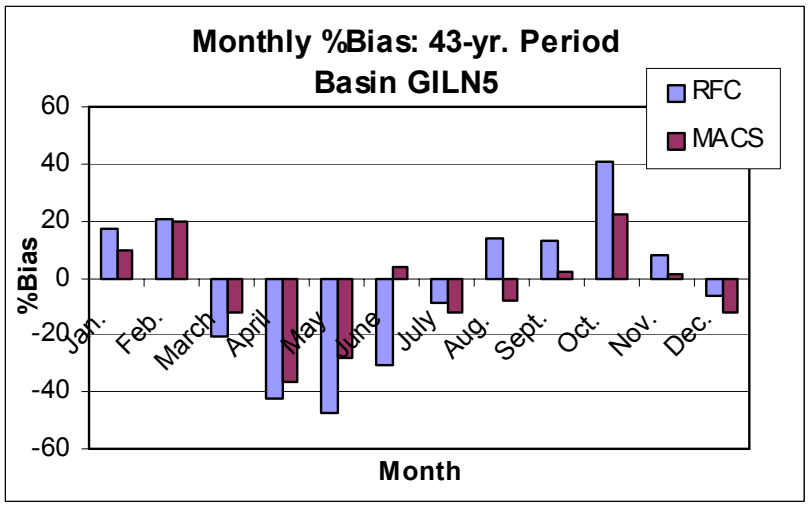
- ***Previous rationale:*** **examine the proportional area and contribution to flow of the three regions. The region considered to make the most significant contribution to flow, which may also comprise the largest proportion of total area, is calibrated initially. Other elevations bands follow, typically lower region next and lastly upper zone.**

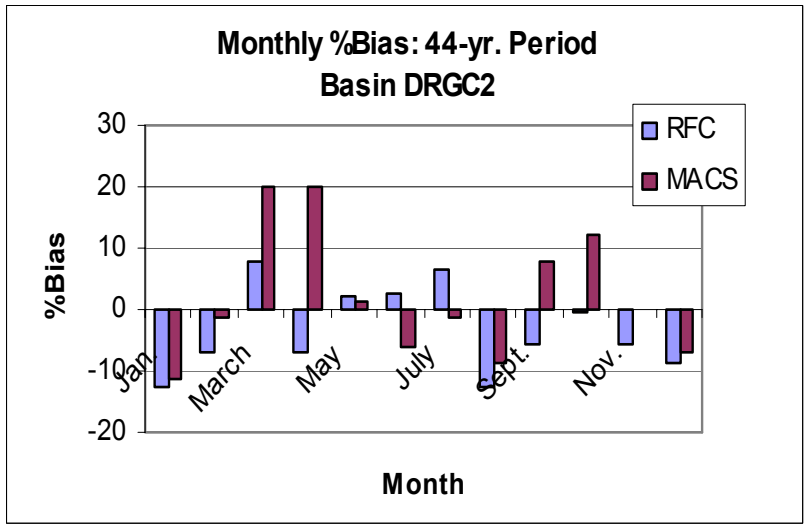
- **In order to not bias the automatic calibration results, *mid-point values* of each parameter range were used for the parameters *not* being calibrated in the initial run.**

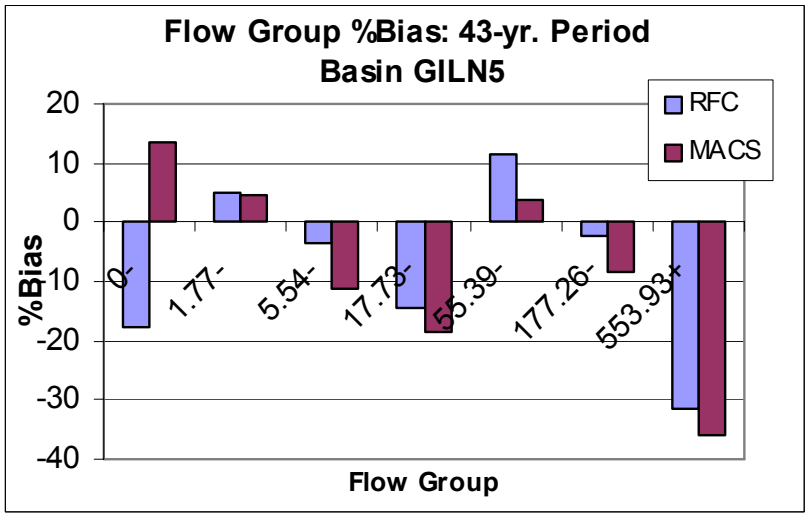
CBRFC Basins

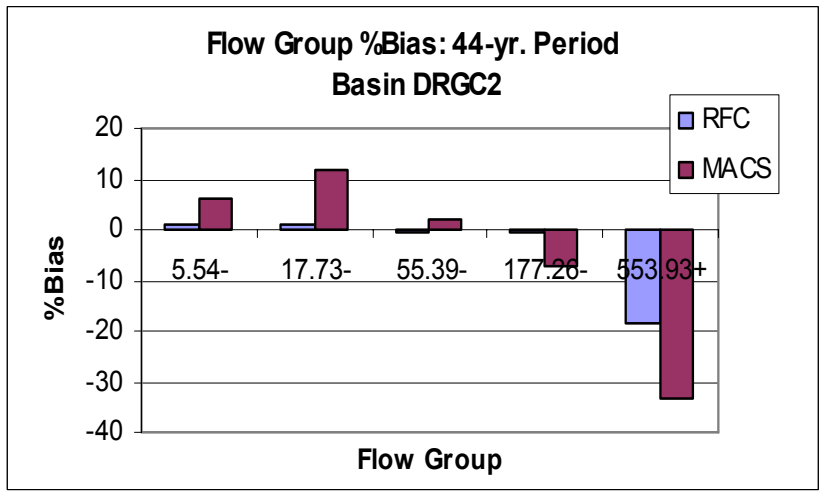
	Gila (GILN5)				
	1976-1987			**1950-1993**	
	RFC	MACS		RFC	MACS
% Bias	6.57	2.68		**-4.36**	-5.4
DRMS	10.186	8.677		8.562	**7.315**
	Virgin (NFUV1)				
	1977-1988			**1951-1998**	
	RFC	MACS		RFC	MACS
% Bias	4.69	3.98		-15.15	**-2.89**
DRMS	2	1.97		2.239	**2.199**
	Animas (DRGC2)				
	1982-1993			**1950-1994**	
	RFC	MACS		RFC	MACS
% Bias	1.69	0.76		**-0.12**	0.72
DRMS	10.718	8.82		9.873	**9.506**

CBRFC Basins

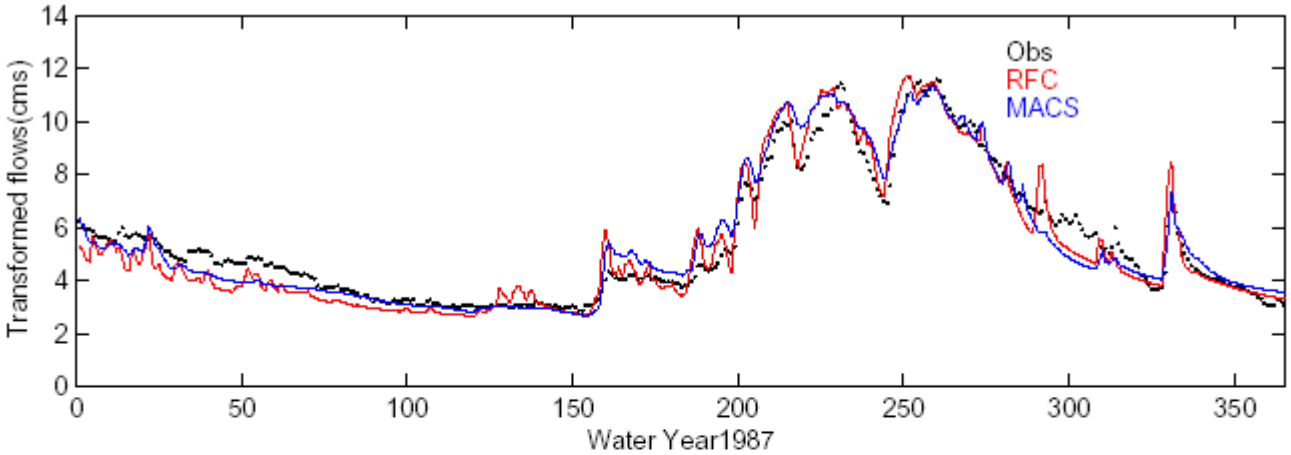


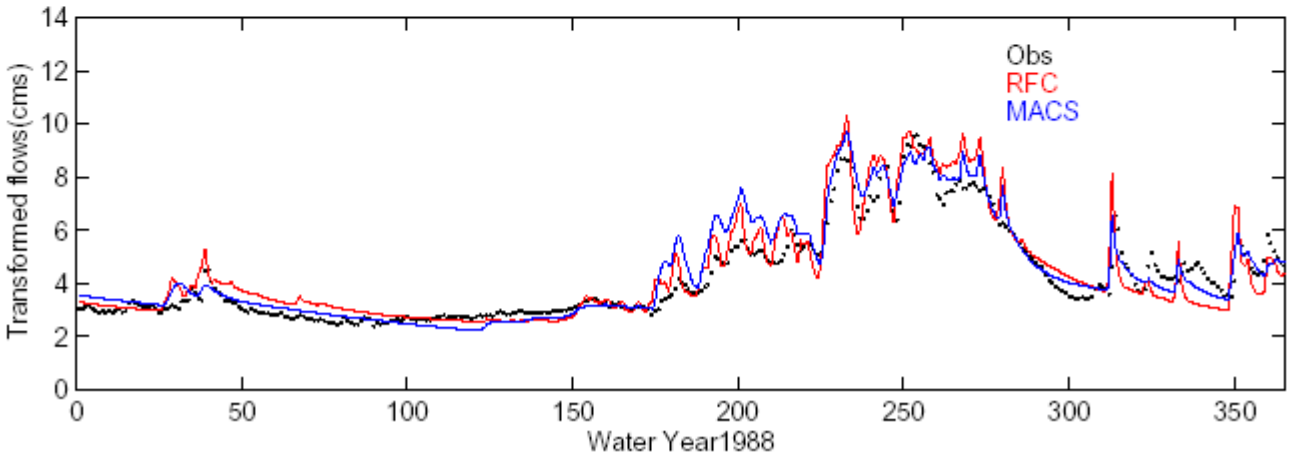




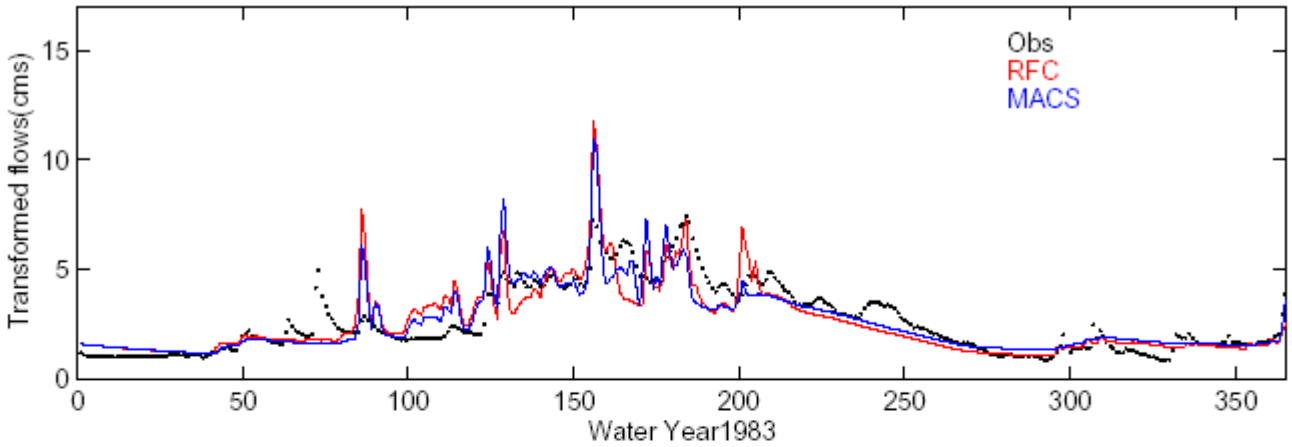


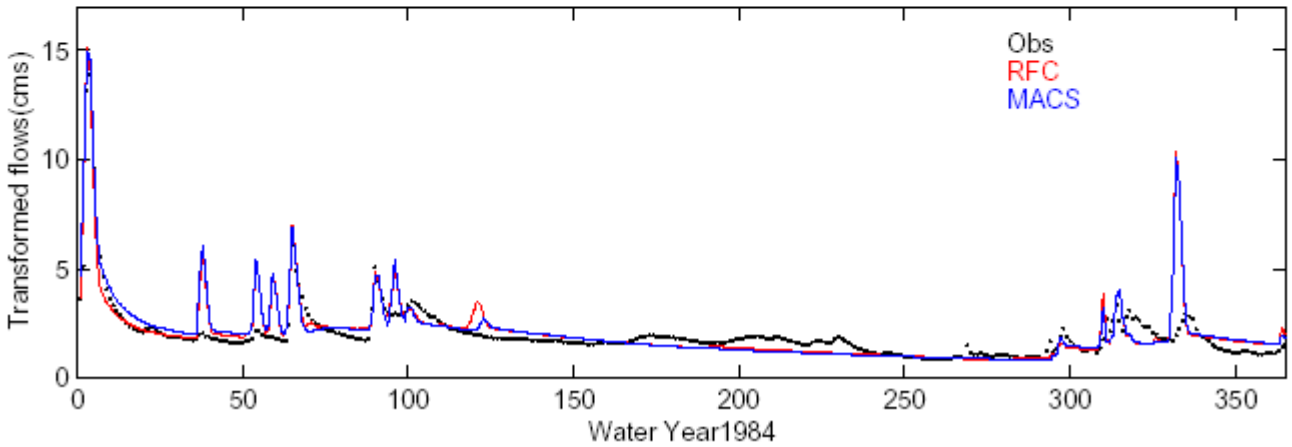
CBRFC Basins - Gila





CBRFC Basins - Animas





MACS – Comments

- **Time-saving, reliable, quality calibrations**
- **Application to 15 Basins / 5 Regions**
- **Statistics and Hydrographs comparable to RFCs**

- **Application / Implementation to other RFC regions in progress**

- ***More Work on Multi-tiered systems (CBRFC)***